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(54) An antimicrobial composition, shaped articles carrying the same and a method of producing an antimicrobial composition.

(57) The invention provides an antimicrobial composition of matter comprising a dry distillate of at least one plant selected from the group consisting of beefsteak plant, bamboo, ginger, mugwort and garlic.

The invention further provides shaped articles containing or carrying the composition of matter and a method of producing the same composition of matter.

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FIELD OF THE INVENTION

This invention relates to an antimicrobial composition of matter derived from a certain cohort of plants and having remarkably high antimicrobial activity, shaped antimicrobial articles either containing or carrying said antimicrobial composition of matter and a method of producing said antimicrobial composition of matter.

BACKGROUND OF THE INVENTION

It is known that aqueous and organic extracts of certain plants including ginger, bamboo grass, mugwort, etc. contain antimicrobially active principles. By way of illustration, Japanese Patent Kokai No. 32705/1985 discloses an antimicrobial composition containing a ginger rhizome extract as an active ingredient.

Derived from naturally-occurring sources, namely plants, such antimicrobial substances are safe and expected to find application in the field of food and cosmetic additive ingredients, among others.

Moreover, though unrelated to antimicrobial use, Japanese Patent Publication No. 8694/1986 describes a deodorant composition containing a dry distillate of tea leaf boiling between 180 and 200°C at 20 mmHg, for instance.

While antimicrobial agents extracted from plants are generally more desirable than synthetic preservatives and synthetic antimicrobial agents as far as safety is concerned, they are usually less active than the synthetic substances. Moreover, because of the characteristic odor, taste and color which trace back to the source plant, a natural substance is often considered unacceptable for food or cosmetic use. Furthermore, the extraction process required is not only time-consuming but entails a complicated after-treatment.

The inventor of this invention having done an extensive exploration into antimicrobial substances occurring in plants arrived at the assumption that antimicrobial substances *in situ*, namely in plants, are mostly in a masked state as its functional groups intrinsic to antimicrobial activity are bound to each other to form a condensate or polymer and such condensed or polymerized substance, if extracted, would not fully deploy its antimicrobial potential. Starting from that assumption, the inventor did further research and developed this invention.

The object of this invention is to provide an antimicrobial composition of matter having high antimicrobial activity and substantially free of the characteristic odor, taste and color of the source plant.

Another object is to provide a shaped antimicrobial article either containing or carrying said substance.

It is a further object of this invention to provide a method of producing said antimicrobial composition of matter.

SUMMARY OF THE INVENTION

The antimicrobial composition of matter according to this invention is a dry distillate of at least one plant selected from the group consisting of beefsteak plant, bamboo, ginger, mugwort and garlic.

The shaped antimicrobial article of this invention is an article either containing or carrying the above antimicrobial composition of matter within or on the surface thereof.

The method of producing an antimicrobial composition of matter according to this invention comprises subjecting the whole, rhizome, foliage or other part of a plant selected from the group consisting of beefsteak plant, bamboo, ginger, mugwort and garlic to dry distillation under reduced pressure at high temperature.

BRIEF DESCRIPTION OF THE DRAWINGS

- Fig. 1 is a high-performance liquid chromatogram of the dry distillate of beefsteak plant;
- Fig. 2 is a high-performance liquid chromatogram of an aqueous extract of beefsteak plant;
- Fig. 3 is a high-performance liquid chromatogram of an ethanol extract of beefsteak plant;
- Fig. 4 is a high-performance liquid chromatogram of the dry distillate of bamboo;
- Fig. 5 is a high-performance liquid chromatogram of an aqueous extract of bamboo;
- Fig. 6 is a high-performance liquid chromatogram of an ethanol extract of bamboo;
- Fig. 7 is a high-performance liquid chromatogram of a dry distillate of ginger;
- Fig. 8 is a high-performance liquid chromatogram of an aqueous extract of ginger;
- Fig. 9 is a high-performance liquid chromatogram of an ethanol extract of ginger;

DETAILED DESCRIPTION OF THE INVENTION

In accordance with this invention, a plant selected from the group consisting of beefsteak plant, bamboo, ginger, mugwort and garlic is used as the source material.

5 The plant, either the whole or a part thereof, is crushed and dried, if necessary, and subjected to dry distillation to provide the objective antimicrobial composition of matter. This dry distillation is carried out at high temperature and under reduced pressure. The typical conditions of dry distillation are 120 - 250 °C, preferably 130 - 220 °C and more desirably 140 - 210 °C, and not more than 100 mmHg, preferably ≤60 mmHg, more desirably 10 - 50 mmHg, and especially 15 - 40 mmHg. If the temperature is too low, the
10 necessary thermal decomposition does not proceed to a satisfactory extent, while too high a distillation temperature results in excessive carbonization and a reduced yield. On the other hand, if the degree of vacuum is insufficient, the yield of the desired distillate will be decreased. The initial fraction of the distillate may be cut off.

The dry distillate thus obtained is usually a viscous fluid but for the ease of handling, it can be diluted
15 with water, ethanol, propylene glycol or the like. The dry distillate may also be further purified.

The activity of the antimicrobial composition of matter obtained by the above procedure is specific to the source plant. Therefore, to obtain an extended antimicrobial spectrum, it is preferable that two or more different plants be subjected together to dry distillation or dry distillates from two or more different plants be used in admixture. Moreover, any and all of the dry distillates from said plants may be used in combination
20 with extracts of other plants or other antimicrobial substances.

The antimicrobial composition of matter obtainable by the above dry distillation procedure is of value as a food or cosmetic supplement or an additive for quasi-drug use, for instance. Thus, the antimicrobial composition of matter according to this invention can be used as an antistaling agent to be incorporated in, or supported on, a sheet or tray for holding food or incorporated in, or supported on, a wrapping paper for
25 wrapping food, an antiseptic to be added to water tanks for aquarium fish, or a cut-flower anti-withering agent. Thus, the term "antimicrobial composition of matter" is used herein to mean any antimicrobially active material whether it can be more properly termed an antibacterial agent, antifungal agent, bacteriostatic agent, antiseptic, preservative, anti-withering agent or the like.

It is suspected that generally the antimicrobial substances in plants are partly present in the free form
30 but mostly in the form of complexes formed as their functional groups pertinent to antimicrobial activity are bound to each other by condensation or polymerization. Therefore, mere extraction of them with water or an organic solvent leaves such complexes intact so that the antimicrobially active functional groups remain masked. Therefore, extracts of plants are lean in the free form of active substances and accordingly show only moderate activity.

In the method of this invention, however, the plant tissue is exposed to the high-temperature and vacuum conditions of dry distillation, with the result that the above-mentioned complexes are thermally decomposed to unmask the antimicrobially active functional groups and, hence, the distillates are rich in the active substances. Thus, the dry distillation according to this invention not only serves to thermally decompose said complexes but also enables fractional recovery of the antimicrobial composition of matter.

40 After an extensive screening of many varieties of plants, the inventor selected beefsteak plant, bamboo, ginger, mugwort and garlic and succeeded in isolating antimicrobial substances having remarkably high activity compared with the substances obtainable by extraction of said plants with water or an organic solvent or substances obtainable by dry distillation of other plants.

45 Examples

The following examples are intended to describe this invention in further detail.

Examples 1 - 2

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Beefsteak plant and crushed bamboo were dried and antimicrobial principles were separated from the materials by the following three methods.

(1) A dry distillation equipment was charged with 200 g of previously dried beefsteak plant or crushed bamboo and the load was dry-distilled at a temperature of about 200 °C and a reduced pressure of 35
55 mmHg. The distillate was recovered in 1500 ml of ethanol.

(2) Twenty (20) grams of previously dried beefsteak plant or crushed bamboo was extracted with 150 g of boiling water.

(3) Twenty (20) grams of previously dried beefsteak plant or crushed bamboo was extracted with 150 g of hot ethanol.

Compared with the samples obtained by methods (2) and (3), the sample obtained by method (1) was remarkably pale in color and suppressed in odor.

Then, the above three samples were analyzed by high performance liquid chromatography (HPLC). The HPLC parameter settings were as follows.

Column: 6 mm ϕ x 150 mm

YMC Packed Column A312, stationary phase ODS

(octadecyl-silica gel)

Mobile phase:

For beefsteak plant: Acetonitrile-water-acetic acid = 30:67:3 (v/v)

For bamboo: Acetonitrile-water-acetic acid = 50:47:3 (v/v)

Detector: UV 280 nm

Flow rate: 1.0 ml/min.

Chart speed: 5 mm/min.

The chromatograms for beefsteak plant are shown in Figs. 1, 2 and 3, which correspond to dry distillation, aqueous extraction and ethanol extraction, respectively. The chromatograms for bamboo are shown in Figs. 4, 5 and 6, which correspond to dry distillation, aqueous extraction and ethanol extraction, respectively. It will be apparent that the chromatograms of dry distillates are considerably different from those of aqueous and ethanol extracts.

Using the above three samples (1), (2) and (3), antimicrobial activity assays were carried out by the following two methods A and B.

Method A

Culture dishes, 90 mm in diameter, were each filled with 1 ml of the sample and 10 ml of sterilized agar medium, and after mixing, the agar was allowed to solidify. The resulting media were inoculated with 0.5 ml portions of Aspergillus niger, Escherichia coli or Staphylococcus aureus suspensions, respectively, and incubated at 35°C for 48 hours. Then, the growth of each microorganism was investigated. As to the bacteria, a loopful of the medium was sampled after incubation and inoculated onto an agar slant for the verification of growth. The media used was GP agar for the fungus and SCD medium for E. coli and Sta. aureus.

Method B

Culture dishes, 90 mm in diameter, were each filled with 10 ml of sterilized agar medium and the agar was allowed to cool and solidify. The resulting media were inoculated with 0.5 ml portions of Asp. niger, E. coli and Sta. aureus suspensions. Separately, 0.1 ml of each sample was dripped on a paper disk, 10 mm in diameter, and allowed to stand at room temperature for 1 hour to dry. This drying procedure of short duration was intended to prevent diffusion of the sample. The dried disk was then placed on the inoculated medium and incubated at 35°C for 48 hours to check for the growth of the microorganism. The medium used was GP agar for the fungus and SCD medium for E. coli and Sta. aureus.

In method A, the results were evaluated according to the following criteria.

Fungus

- : Growth is found in entire area
- +: No growth in less than 50% of area
- + +: No growth in 50% or more of area
- + + +: No growth at all

Bacteria

- : Colonies are found in entire area
- +: No colonies in less than 50% of area
- + +: No colonies in 50% or more of area
- + + +: No colonies at all

The growth on the slant medium was evaluated on the two-stage scale of o (no growth) and x (growth).

In method B, the following evaluation criteria were used.

Fungus

- 5 -: Growth is found on entire disk
 +: No growth on part of disk
 ++: No growth on disk
 +++: A zone of inhibition is found

10 Bacteria

- : No zone of inhibition around disk
 ±: A zone of inhibition within 1 mm from periphery of disk
 +: A zone of inhibition within 5 mm from periphery of disk
 15 ++: A zone of inhibition beyond 5 mm from periphery of disk

The data obtained by method A are shown in Table 1 and those obtained by method B in Table 2. The results of blank tests using ethanol alone are also shown as controls in Tables 1 and 2.

Table 1

Plant		Asp. niger	E. Coli	Sta. aureus
Beefsteak plant	Dry distillate	+++	+++/o	+++/o
	Aqueous extract	+	-/x	++/x
	Ethanol extract	++	-/x	-/x
Bamboo	Dry distillate	+++	+++/o	+++/o
	Aqueous extract	-	-/x	+/x
	Ethanol extract	++	-/x	-/x
Control	(Ethanol)	+	+/x	-/x

Table 2

Plant		Asp. niger	E. Coli	Sta. aureus
Beefsteak plant	Dry distillate	±	+	++
	Aqueous extract	-	-	-
	Ethanol extract	+	-	-
Bamboo	Dry distillate	++	++	-
	Aqueous extract	±	++	-
	Ethanol extract	±	+	-
Control	(Ethanol)	±	-	-

Examples 3 - 5

- 50 Using ginger (Example 3), mugwort (Example 4) and garlic (Example 5) instead of beefsteak plant and bamboo, the dry distillation, aqueous extraction and ethanol extraction procedures of Example 1 were otherwise repeated to provide the respective samples.

The chromatograms (HPLC) of the dry distillate, aqueous extract and ethanol extract of ginger as recorded by the same procedure as described in Example 2 (bamboo) are shown in Figs. 7, 8 and 9, 55 respectively.

The antimicrobial activity of each sample obtained above was assayed as in Example 1. The data obtained by method A are shown in Table 3 and those obtained by method B in Table 4. The results of blank tests using ethanol alone are also shown as controls in Tables 3 and 4. Compared with the aqueous

and ethanol extracts, the dry distillates were by far pale in color and suppressed in odor.

Table 3

Plant		Asp. niger	E. Coli	Sta. aureus
Ginger	Dry distillate	+++	+++/o	+++/o
	Aqueous extract	-	-/x	+ /x
	Ethanol extract	+	-/x	+++/o
Mugwort	Dry distillate	+++	+++/o	+++/o
	Aqueous extract	++	-/x	+ /x
	Ethanol extract	+	-/x	-/x
Garlic	Dry distillate	+++	+++/o	+++/o
	Aqueous extract	++	-/o	-/x
	Ethanol extract	+++	-/x	-/x
Control	(Ethanol)	+ or -	- or +/x	-/x

Table 4

Plant		Asp. niger	E. Coli	Sta. aureus
Ginger	Dry distillate	±	+	++
	Aqueous extract	-	-	-
	Ethanol extract	+	-	+
Mugwort	Dry distillate	±	++	++
	Aqueous extract	±	-	-
	Ethanol extract	-	-	-
Garlic	Dry distillate	+	++	±
	Aqueous extract	±	++	-
	Ethanol extract	±	-	-
Control	(Ethanol)	- or ±	-	-

Example 6

The dry distillates, aqueous extracts and ethanol extracts of beefsteak plant, bamboo, ginger, mugwort and garlic used in the foregoing examples were respectively added to rice cake, bread dough, sausage and miso (bean paste) batches at the level of 1% by weight (inclusive of solvent). The respective food products were then prepared and their shelf-lives were investigated. Using the corresponding product not containing any of the additives as control, the activity of each antimicrobial additive was evaluated on the 3-grade scale of C (no change), B (effective) and A (very effective). The results are shown in Table 5.

Table 5

	Rice cake	Bread	Sausage	Miso
Beefsteak plant				
Dry distillate	A	A	A	A
Aqueous extract	B - C	B - C	B	B
Ethanol extract	B	B	C	C
Bamboo				
Dry distillate	A	A	A	A
Aqueous extract	B - C	C	B	B
Ethanol extract	B - C	C	B	C
Ginger				
Dry distillate	A	A	A	A
Aqueous extract	B - C	C	B - C	B
Ethanol extract	B	B - C	B - C	A - B
Mugwort				
Dry distillate	A	A	A	A
Aqueous extract	B	B	C	B
Ethanol extract	B - C	B - C	C	B - C
Garlic				
Dry distillate	A	A	A	A
Aqueous extract	A - B	B	B	C
Ethanol extract	A	A - B	C	C

Example 7

Nonwoven fabrics were respectively impregnated with the dry distillates, aqueous extracts and ethanol extracts of beefsteak plant and bamboo used in the Examples. After drying, each fabric was spread on a tray, slices of raw fish were placed on the fabric and the whole was wrapped up. With the aqueous extracts or ethanol extracts, the antistaling effects were almost negligible. In contrast, when the dry distillates of this invention were used, definite antistaling effects were obtained.

Thus, compared with the conventional aqueous and ethanol extracts of plants, the antimicrobial compositions of matter according to this invention are remarkably higher in antimicrobial activity and less pronounced in odor, taste and color.

Moreover, the method of this invention is advantageous in that since the necessary composition of matter can be obtained by mere dry distillation of the source plant, the production process is remarkably simple as compared with the conventional extraction procedure using water or an organic solvent.

Claims

1. An antimicrobial composition of matter comprising a dry distillate of at least one plant selected from the group consisting of beefsteak plant, bamboo, ginger, mugwort and garlic.
2. An antimicrobial article containing or supporting the antimicrobial composition of matter claimed in claim 1.
3. A method of producing an antimicrobial composition of matter comprising subjecting a plant selected from the group consisting of beefsteak plant, bamboo, ginger, mugwort and garlic to dry distillation under reduced pressure at high temperature.

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4. The method according to claim 3 wherein said dry distillation is carried out at a temperature of 120 to 250 °C under a reduced pressure not exceeding 100 mmHg.

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Fig. 1

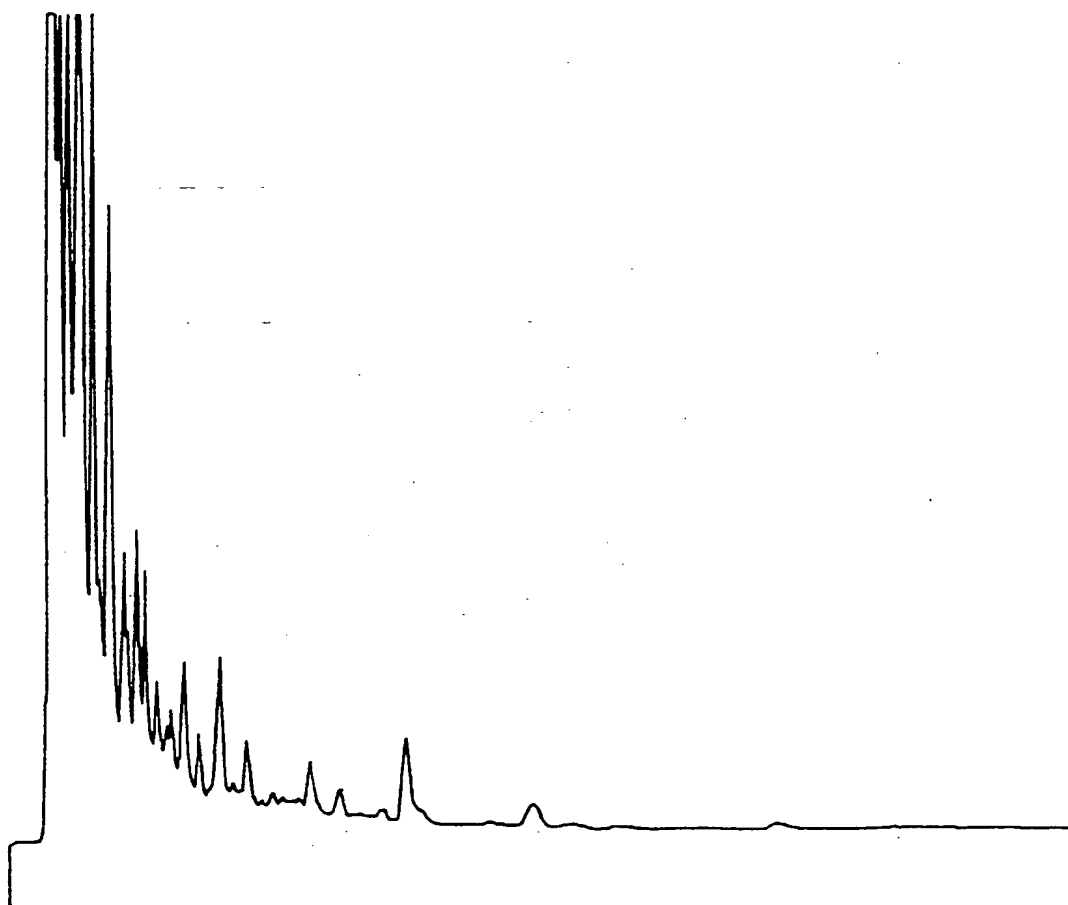


Fig. 2

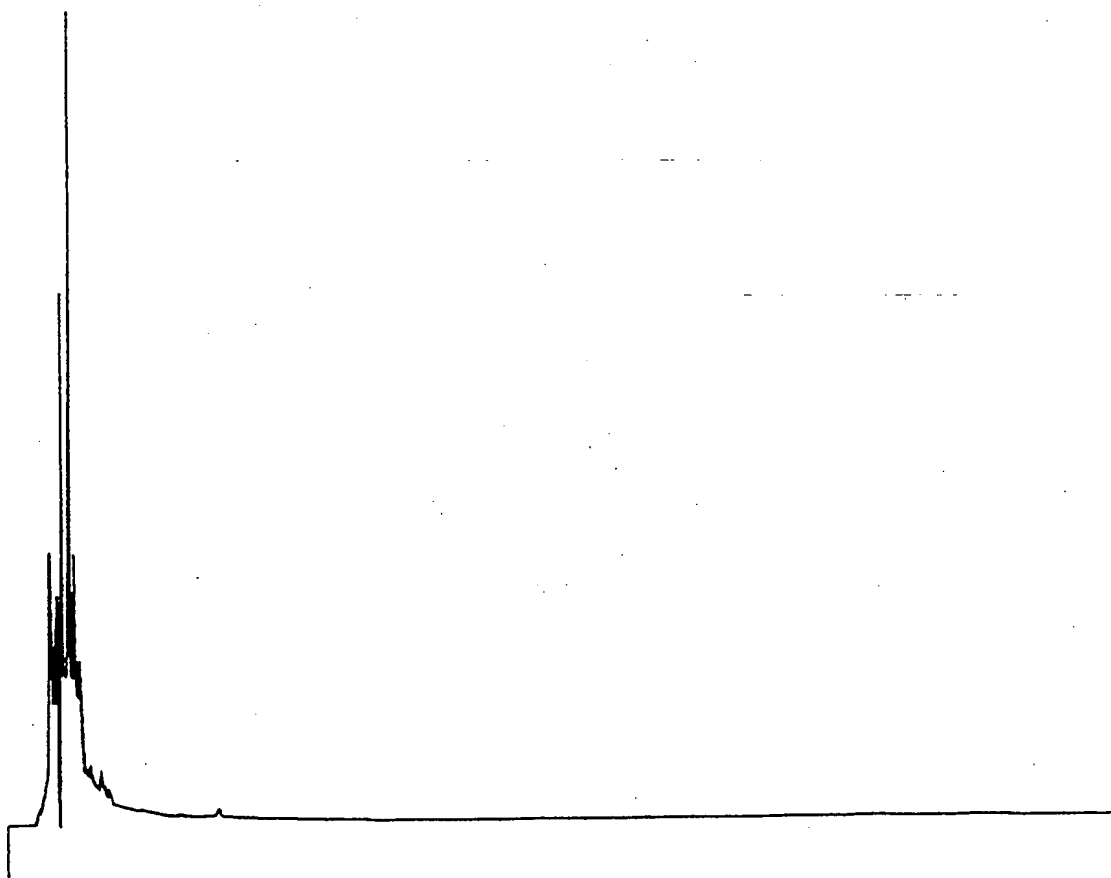


Fig. 3

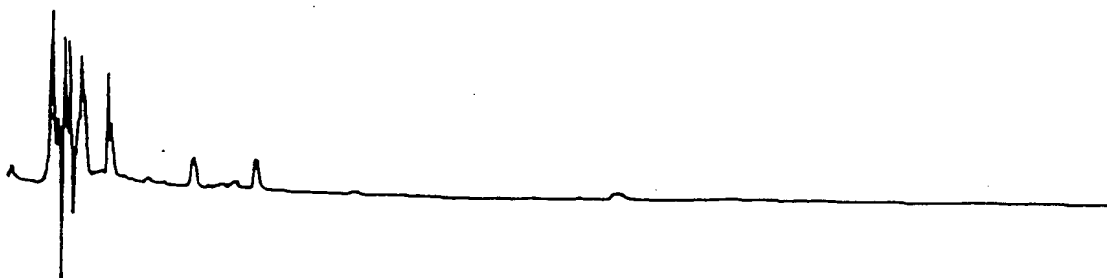


Fig. 4

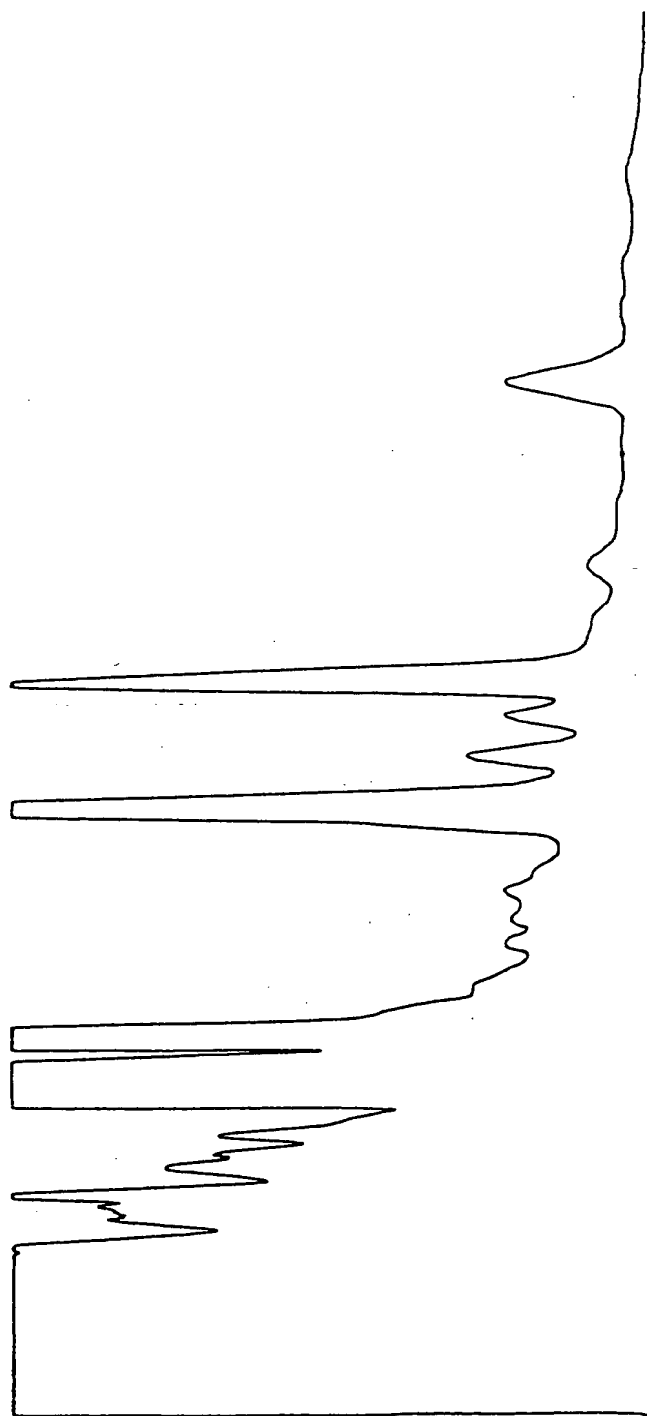


Fig. 5

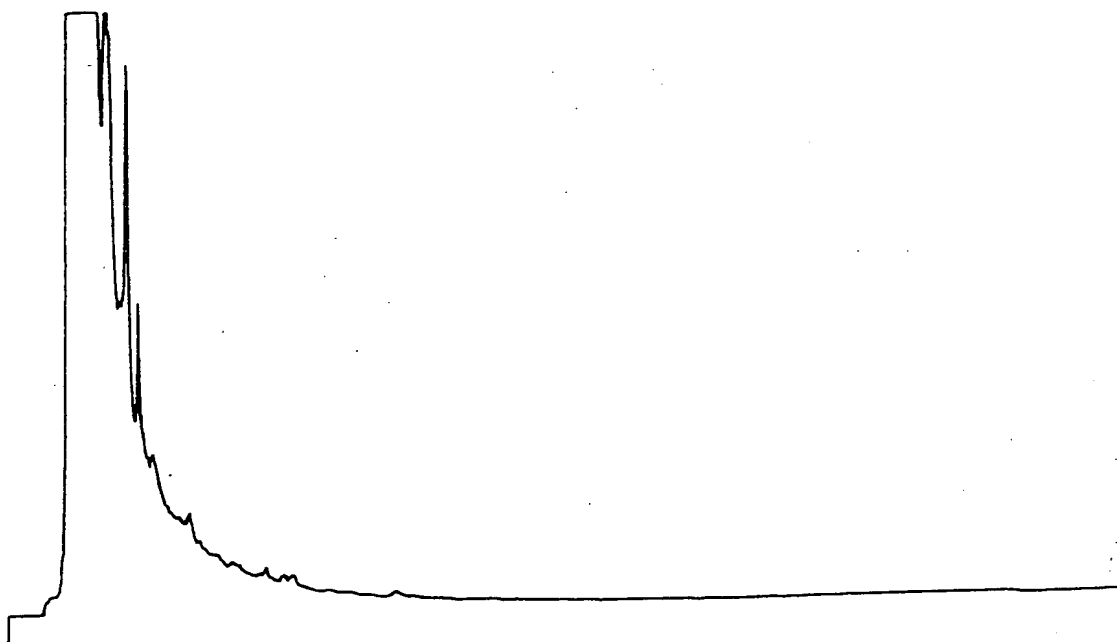


Fig. 6

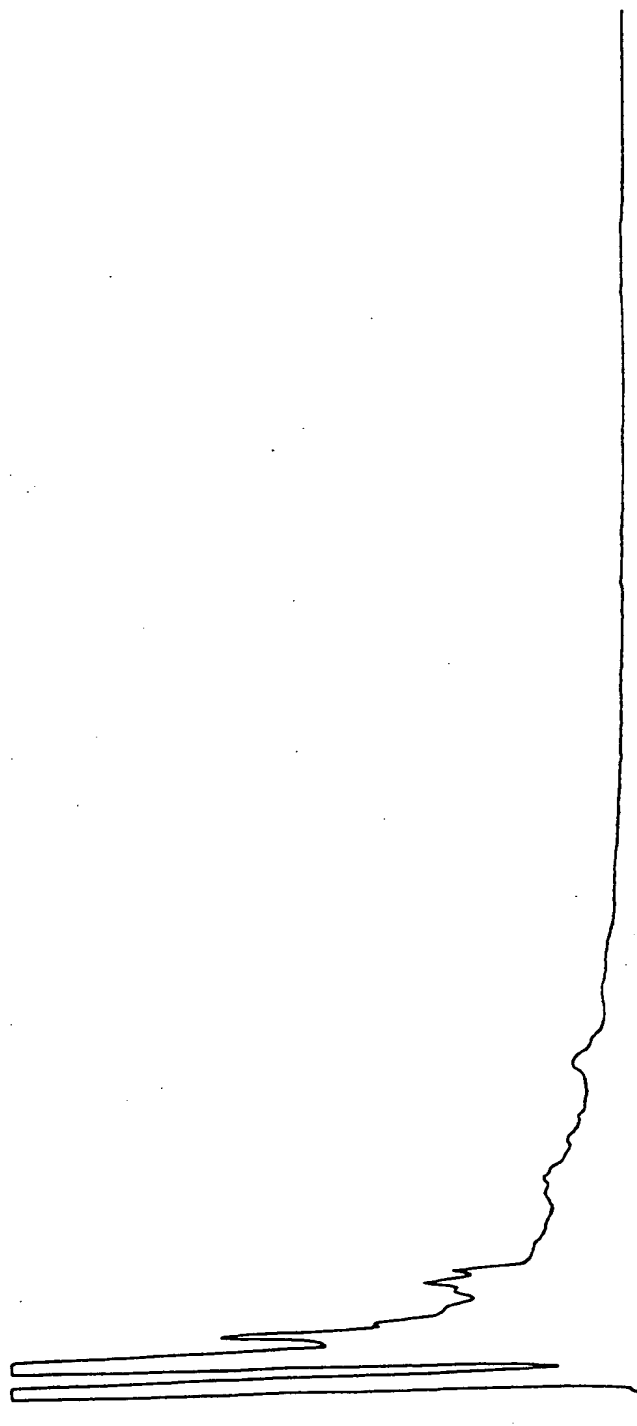


Fig. 7

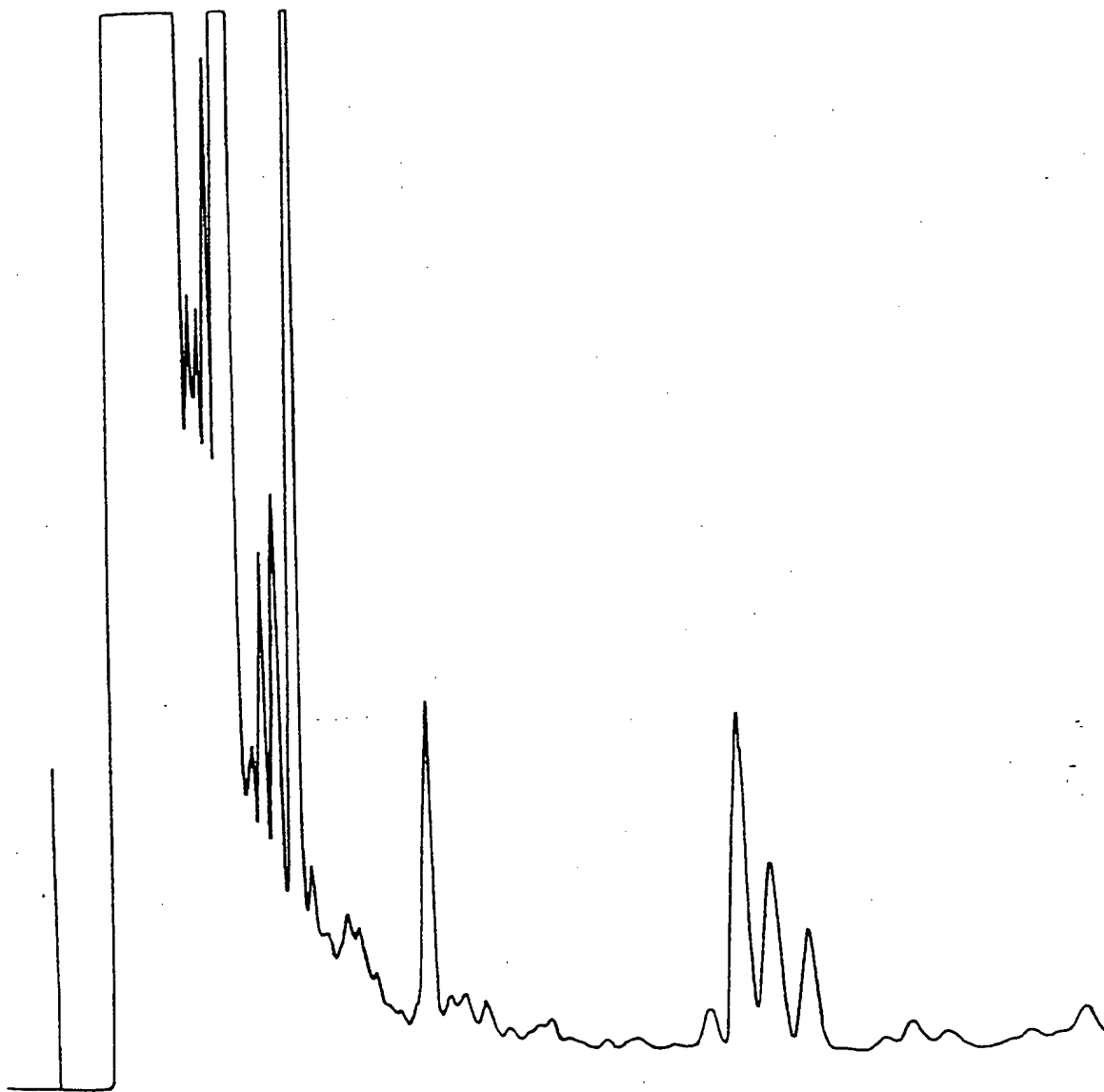


Fig. 8

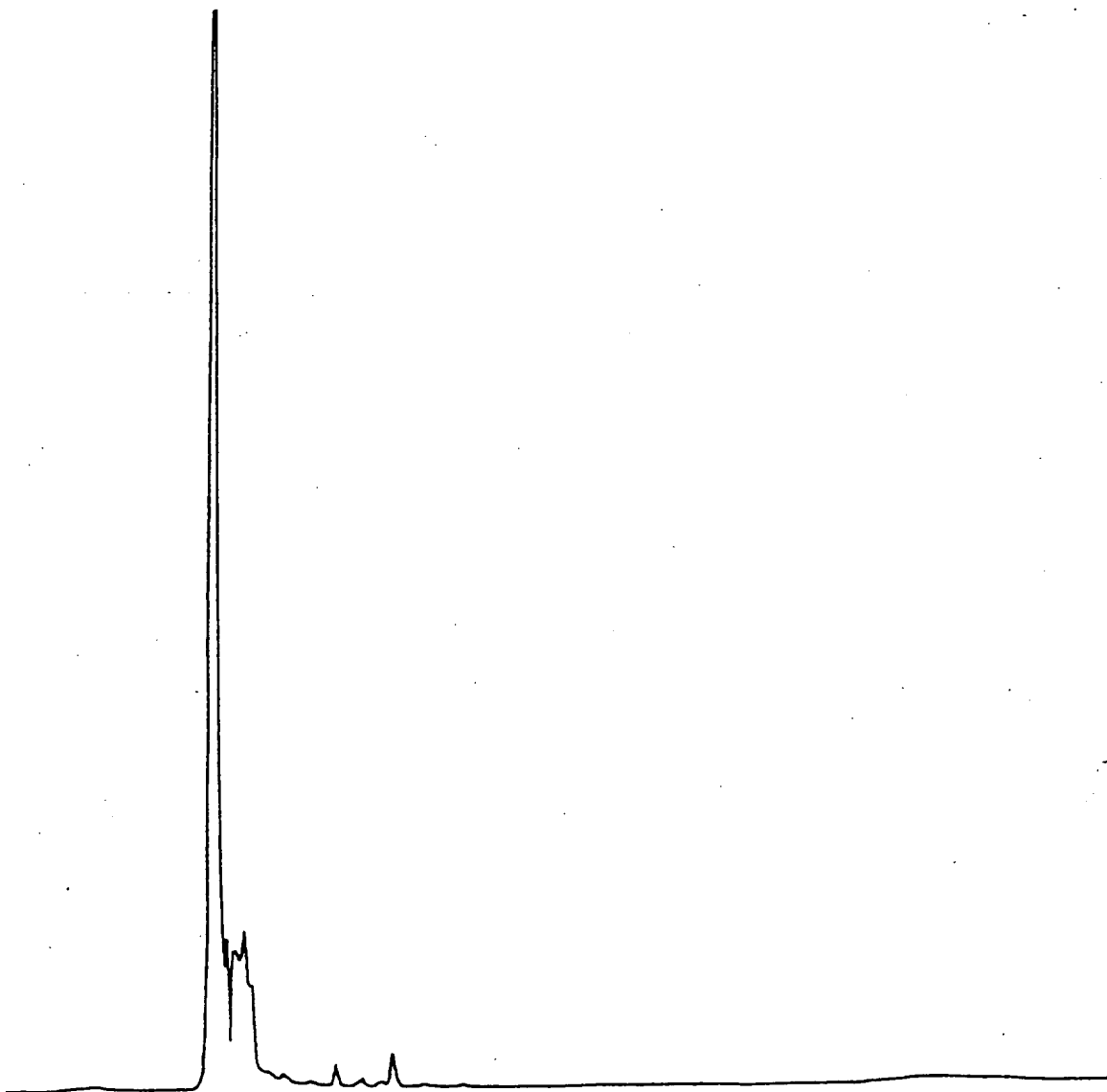
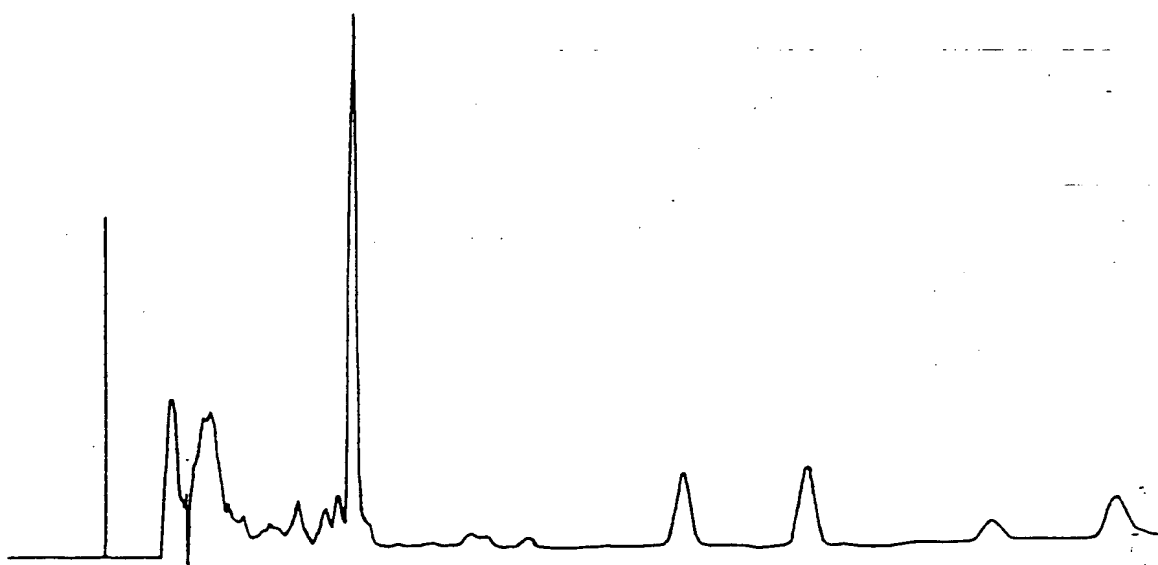


Fig. 9





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EUROPEAN SEARCH REPORT

Application Number
EP 94 10 1236

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cls.)
X	GB-A-1 157 717 (Y. SAKAMOTO) * claims *	1-4	A01N65/00
X	GB-A-1 300 966 (K. SAKAMOTO) * claims *	1-4	
X	PATENT ABSTRACTS OF JAPAN vol. 014, no. 310 (C-0736) 4 July 1990 & JP-A-21 007 265 (NIPPON DRY CHEM CO LTD) 19 April 1990 * abstract *	1-4	
D,A	PATENT ABSTRACTS OF JAPAN vol. 09, no. 153 (C-288) 27 June 1985 & JP-A-60 032 705 (SHIRAIMATSU SHINYAKI) * abstract *	1-4	
A	DATABASE WPI Week 9034, Derwent Publications Ltd., London, GB; AN 90-257570 & JP-A-2 180 804 (NIPPON OILS & FATS KK) * abstract *	1-4	
The present search report has been drawn up for all claims			TECHNICAL FIELDS SEARCHED (Int.Cl.5)
			A01N
Place of search		Date of completion of the search	Examiner
THE HAGUE		18 April 1994	Dalkafouki, A
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